南極ドームふじ氷床コアの O_2/N_2 による年代決定の高精度化（8〜16.5 万年前）

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Improvement in dating of the Dome Fuji ice core using O_2/N_2 (80-165 ka)

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The Dome Fuji ice core preserves valuable information on the climatic and environmental changes over the last 720 kyr, which allows us to investigate climate forcings and mechanisms in the Earth's system. Precise ice core chronology is essential to determine sequences and durations of climate events as well as to examine the phasing with other well-dated paleoclimatic records. Kawamura et al. (2007) found that variation in O_2/N_2 ratio of occluded air in the Dome Fuji ice core is synchronous with local solstice insolation. By using this synchronicity, they established chronology of the first Dome Fuji ice core with accuracy generally better than ±2000 years (DFO-2006). This accuracy is much better than those of the Dome C and Vostok ice cores (±6000 years) covering similar time period. However, O_2/N_2 ratio of Kawamura et al. (2007) between 80 and 160 kyr BP has large variability probably because of large corrections for gas-loss during core storage, and it was recently pointed out by using detailed age matching with EDC and Chinese speleothem records that the DFO-2006 chronology around 100 kyr BP has an error of 3 kyr toward the older direction (Fujita et al., 2015). In order to examine and improve the Dome Fuji chronology by using O_2/N_2 ratio, we reanalyzed O_2/N_2 ratio of occluded air in the first Dome Fuji ice core between 80 and 165 kyr BP.

Because the first Dome Fuji core has been stored for about 20 years, we expect that O_2 has been selectively lost from near-surface ice. We thus tested different thickness of surface shaving, and found that shaving-off of about 1 cm of surface (and only using the inner part of the ice) is required for precise measurements. Because of this careful examination and improvement of methodology, our new O_2/N_2 data set on average do not indicate preferential loss of O_2. O_2/N_2 has large high-frequency noise (typical amplitude ~5 ‰) in the transition zone where air bubbles and clathrate hydrates coexist, but below of this zone, noise reduces towards deeper depths (amplitude >1 ‰). By using the new data, we updated the O_2/N_2 time scale over the 80-165 ka period. There were sharp steps of the annual layer thickness at 94.2 and 150.3 kyr BP in the DFO-2006 (Fujita et al., 2015), but these unnatural steps disappeared in the DFO-2016. Deviations from speleothem age decreased compared to the DFO-2006, and are probably less than 1200 years. These results indicate that the revised chronology greatly improved from the DFO-2006 chronology.

References

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